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ABSTRACT

This study attempted to answer the following three questions: 1) Do students of grades four through seven perform equally well on both syncretistic understanding and logical thinking? 2) Do boys perform as well as girls on these two types of thinking? 3) Do students whose parents have a higher educational level perform as well as students whose parents have a lower educational level on these two types of thinking? Proverb Tests and Logic Tests were administered to 361 students from a Bucks County, Pennsylvania school district. Results were formulated on the basis of the relationships among several variables. It is suggested that the question of sex differences has been reopened by the findings of this study. The differences, for example, between boys and girls on the quantificational logic items but not on the sentential logic and classical syllogism items suggests that girls may develop faster in certain principles of logical thinking. The need for further study was emphasized. (BW/Author)

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A STUDY OF LOGICAL THINKING

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Introduction

Piaget (1926) has described the characteristic of preadolescent children of arriving at syncretistic understanding, e.g., a general understanding of the whole before the parts are analyzed. For a child at this stage of development, the understanding of details is only a function of the general understanding. For an adult a syncretistic understanding may arise through the skipping of details or difficult words. Piaget (1926) observed preadolescent children display syncretistic understanding when they were asked to find different ways of expressing the ideas contained in proverbs (Test des proverbs, Claparede, 1924). He frequently found the students ignored details and used irrelevant parallelisms as the key to their solutions and thus displayed a syncretistic understanding. The Proverbs Test of Claparede was used in the current study as a measure of the extent to which a child has syncretistic understanding.

Hill (1960) developed a 100-item test to measure the ability of children to think logically. The items in the test were selected to be representative of three broad areas of elementary logic: (1) sentential logic, (2) classical syllogism, and (3) logic of quantification. An example of each type of test item is included here:

Sentential Logic

If this is Room 9, it is fourth grade.
This is Room 9.
Is it fourth grade?

A. Yes B. No

Classical Syllogism

All of Ted's pets have four legs.
No birds have four legs.
Does Ted have a bird for a pet?

A. Yes B. No

Logic of Quantification

None of the pictures was painted by anyone I know.
I know Hank's sister.
Did she paint one of the pictures?

A. Yes B. No

All Items consisted of two statements or premises, a question, and two possible responses. In each item the question required the student to discriminate between a necessary conclusion and the negation of a necessary conclusion.

Hill considered her test to measure hypothetical-deductive thinking for she interpreted her findings that children of ages six, seven, and eight could in fact recognize valid conclusions derived from hypothetical premises as contrary to the findings of Piaget.

O'Brien and Shapiro (1968) felt that an adequate consideration of hypothetical-deductive thinking should include a test of the logical necessity of the conclusion. That is, in addition to discriminating between a conclusion and its negation, whether any conclusion follows. The test used by Hill was modified to include a third response "not enough clues" so that the aspect of testing of the logical necessity of a conclusion was included. This modified test, hereafter referred to as the Logic Test was used in the current study and represents a measure of what this author will refer hereafter to as "logical thinking".

Two types of thinking have been singled out which are related to hypothetical-deductive reasoning. First is syncretistic understanding as measured by the Proverbs Test. Syncretistic understanding as described by Piaget (1926) poses a barrier to a child truly reasoning hypothetical-deductively. Does this barrier to true hypothetical-deductive reasoning disappear in the upper elementary school grades or is it retained into the junior high grades? The implications for the curriculum developer here should be obvious.

The second type of thinking cited is logical thinking as measured by the Logic Test. The Logic Test asks the student to test the logical necessity of a conclusion and to discriminate between a conclusion and its negation. That

early elementary school students can discriminate between a conclusion and its negation has been found by the studies of both Hill (1960) and O'Brien and Shapiro (1968). However, O'Brien and Shapiro (1968) also found that early elementary school students cannot test the logical necessity of a conclusion. Does this ability appear in students in the upper elementary grades or must the student wait till the junior High school years before he can test the logical necessity of a conclusion?

Although not a major part of the current study, another question naturally arises. Since deductive thinking is a process by which one reasons from the general to the specific, it is entirely possible that students must free themselves from syncretistic understanding before they can truly reason deductively and test the logical necessity of a conclusion. Although the original intent of the study was not to answer any questions regarding the relationship between these two aspects of hypothetical-deductive reasoning, the data might suggest some good hypotheses for further study.

Claparede (1924) suggests there are differences between the performance of the boys and girls on the Proverbs Test. Therefore another question is suggested for study. Do boys and girls perform equally well on the two tests of reasoning in this study? This question is of secondary importance, but because of the precedence, is included here.

For the purpose of this study the highest educational level of the parent (HELP) was used as a simple measure of home background. Do in fact students with a high educational level of parents perform as well as students with a lower educational level of parents?

Three general questions about both syncretistic understanding and logical thinking have been proposed:

1. Do students of grades four through seven perform equally well on these two types of thinking?

2. Do boys perform as well as girls on these two types of thinking?

3. Do students with a higher educational level of parents perform as well as students of lower educational level of parents on these two types of thinking?

The Present Research

The Proverbs Test and the Logic Test were administered in late September and early October 1970. The two tests were administered in three sessions on consecutive days. All of the tests were administered in an unspeeded setting, all students had adequate time to complete all questions in each testing session.

The highest educational level of the parent (HELP) was recorded from school records. If two different educational levels was represented in the school records the higher was used for this study. Thus if one parent completed only the first eight years of schooling and the other had a high school diploma, the latter was recorded for their child. Students were classified in three categories depending upon the highest educational level of their parents (1) less than high school graduate, (2) high school graduate, and (3) some education beyond the high school.

All students who participated in the study were from a northern Bucks County (PA) school district. All students from three of the eight elementary schools in the district participated plus one fourth grade class from a fourth school. Three seventh grade sections were selected for participation in the study.

There were a total of eighty fourth grade students for which complete data were available and on which the analysis was performed. There were 90 fifth graders, 96 sixth graders, and 95 seventh graders available for analysis. The total number of students used in the study was 361.

Table I shows the number of students in each group when classified by grade, sex, and HELP category. There were a total of 181 girls and 180 boys in the study. Seventy-two students had a highest educational level of the parent less than a high school diploma; 168 students had at least one parent with a high school diploma; 121 students had at least one parent with some post high school education.

Results

Although not a major part of the study, the analysis and findings about the relationships among the tests and subtests are presented first. Both syncretistic understanding as measured by the Proverbs Test and logical thinking as measured by the Logic Test have already been discussed in the larger framework of hypothetical-deductive reasoning. If students need to free themselves from syncretistic understanding before they are able to reason truly deductively and test the logical necessity of a conclusion, one would expect a fairly high correlation between the scores on the Proverbs Test and the Logic Test. Table II shows the calculated correlation coefficients showing the relationship between the Proverbs Test (PT) and Sentential Logic (L1), Classical Syllogism (L2), Logic of Quantification (L3), and the total Logic Test (LT) for the fourth graders, fifth graders, sixth graders, and seventh graders separately and the total sample of 361 students used in the study.

All the correlations for the total group, grade four, grade five, and

TABLE I

Number of Students Classified by

Grade, Sex and HELP Categories

		H E L P Categories		
Grade	Sex	Less Than High School Diploma (HS-)	High School Diploma (HS)	Some Post High School Education (HS+)
4	F	6	18	13
	M	10	18	15
5	F	7	21	20
	M	9	21	12
6	F	4.	28	18
	M	14	20	12
7	F	10	23	13
	M	12	19	18

grade six were significant at the .05 level. In grade seven only the correlation between L2 and the Proverbs Test was significant. Although the correlations are significant, they tended to be small in magnitude.

The analysis of variance on the Proverbs Test showed significant differences among grade levels. Scheffe's post hoc procedures were used to make all possible pairwise comparisons. Only the grade five-grade six comparison was not significant. There were significant gaps or gains therefore between grade six and grade seven. Students for the most part show gains over the span of grades four through seven. There seems to be a slight leveling off in grade five and grade six, before another significant gain shown by the seventh graders.

No significant differences were noted on the Proverbs Test between boys and girls. Likewise there were no significant differences among groups of students classified according to highest educational level of the parent (HELP). None of the interaction terms was significant.

On the total Logic Test and its component subtests all the analyses of variance showed significant differences among grade levels. The Scheffe post hoc procedures were used to make all possible pairwise comparisons among grade levels. Only the comparisons involving grade seven were significant, i.e., grade seven was singly different from grade four, five, and six. Thus the only significant gap or gain on L1, L2, L3 and the total Logic Test was made by the seventh graders.

Significant differences were further noted on L3 and the total Logic Test between boys and girls. The girls scored significantly high on both L3 and the total Logic Test.

In no test or subtest was HELP a significant effect. Likewise no significant interaction terms were found on these analyses.

TABLE II

Correlations of

Logic Test and Subtests with Proverbs Test

TEST	GROUP				
	Total (N = 361)	Grade 4 (N = 80)	Grade 5 (N = 90)	Grade 6 (N = 96)	Grade 7 (N = 95)
L1	.40*	.41*	.36*	.32*	.17
L2	.39*	.41*	.29*	.25*	.22*
L3	.41*	.35*	.48*	.36*	.01*
LT	.45*	.44*	.44*	.36*	.15*

*p < .05
at the .05 level of significance N = 80, r = .22; N = 90, r = .21; N = 100, r = .19
taken from Table VII, Fisher and Yates (1963)

On the other hand the correlations among L1, L2, L3, and LT (Table III) were significant and also higher indicating a stronger relationship among the Logic Test and its subtests than between the Proverbs Test and the Logic Test and its components.

TABLE III

Correlations of Logic Test and its Subtests

for the Total Group

	L1	L2	L3	LT
L1	1.00			
L2	.63	1.00		
L3	.67	.70	1.00	
L4	.93	.81	.88	1.00

It was noted earlier that there was no strong relationship between the Proverbs Test and the Logic Test or its component subtests. This has been further shown in the post hoc comparisons. There seems to be a more consistent and stronger growth over the span of grades four through seven on the Proverbs Test. On the total Logic Test and its subtests the only significant difference involved seventh grade. Seventh grade scored significantly higher than any of the other grades. The students perform differently on the Proverbs Test and Logic Test and its components.

Scheffe contrasts using the corresponding coefficients for linear quadratic, and cubic trends were used. These may be interpreted with appropriate caution in a similar manner to the usual trend analysis.

A linear trend was noticed for the Proverbs Test. Means increased in a linear fashion from grades four through seven. It might be noted that there was some "peaking out" on this test in grade seven. Fifteen out of 95 or about one-sixth of the seventh graders had a perfect score of ten. At the other extreme only one out of 80 or about one per cent of the fourth graders had a perfect score.

The results of the trend analysis for the total logic test and its subtests was completely consistent. In each case both the linear and the cubic contrasts were significant. Overall there was an increase in scores from grade four through seven as noted by the significant linear contrasts. A slight dip or wrinkle was noticed in grade six, causing a significant dubic contrast. Apparently there is a leveling off or actual decrease in sixth graders in the ability to think

logically as measured by the total Logic Test and its component subtests before students again make the increase noted in seventh grade. It might be further noted that this increase from grade six to seven was the only one that was found significant using the Scheffe pairwise analysis.

Discussion

The manifestation of syncretistic understanding as measured by the Proverbs Test declined with age. The increase in mean represents a decline in sycretistic understanding. Significant differences were found between grades four and five and between grades six and seven. In fact, the mean on the Proverbs Test for the fourth grade was 4.96 just slightly less than 50%. This increased to almost 80% (7.96) out of 10 in the seventh grade. It might also be noted that quite a few seventh graders got perfect scores, whereas only one fourth grader had a score of ten.

The finding that there were no significant differences between boys and girls stands in contrast to the original work of Claparede (1924) in France. There may be several reasons for this finding. First the original test has been translated and slightly modified for the current study. In addition, the population of American children might be substantially different from the original population in France.

The finding of no significant differences among groups of children of different HELP categories was somewhat surprising. The three HELP categories were less than a high school education, high school education, and some post high school education.

On the total Logic Test and its components a similar significant difference among grade levels was found. The difference between seventh grade and each of the other grades was largely responsible for this finding.

Significant differences between boys and girls in favor of the girls were found on L3, quantificational logic and the total Logic Test. This finding stands out in contrast to the early work of Hill (1960) and O'Brien and Shapiro (1968) in which no significant sex differences were found.

As in the Proverbs Test, no differences were found among the HELP categories. The lack of difference here and on the Proverbs Test is significant. Although quite a range of highest educational level of the parent was represented (from elementary school to Ph.D) the extremes were not represented in large numbers. A recent finding of Shapiro and O'Brien (in press) suggests that children from low-income neighborhoods do in fact perform differently on logical thinking tests.

The additional finding of little relationship between the Proverbs Test and the Logic Test is of some importance. Many types of logical thinking skills have been studied in the past. Much more study is apparently needed before all of this can be put together into an overall theory of the development of different aspects of logical thinking. Certainly syncretistic understanding seems less related to the type of logical thinking in this study than is suggested by Piaget's observations.

Several directions seem to be suggested by the current findings. Specifically, the question of sex differences has been reopened by the findings of the current study. The dif erences between boys and girls on the quantificational logic items but not on the sentential logic and classical syllogism items suggests that girls may develop faster in certain principles of logical thinking. Or on the hand, this finding may be a peculiarity due to sampling. In any case further study seems called for.

The lack of any significant differences on the HELP categories coupled with Shapiro and O'Brien (1970) suggestion of the differences between children from low and middle income neighborhoods suggests another area to be studied. What SES variables seem to be related to ability to think logically? Studies of this type might help to explicate the nature of the influence of SES variable on logical thinking. Shapiro and O'Brien (1970) suggest it may be as simple as everyday usuage of language.

FIGURE I

Proverbs Test: Graph of Means by Grade

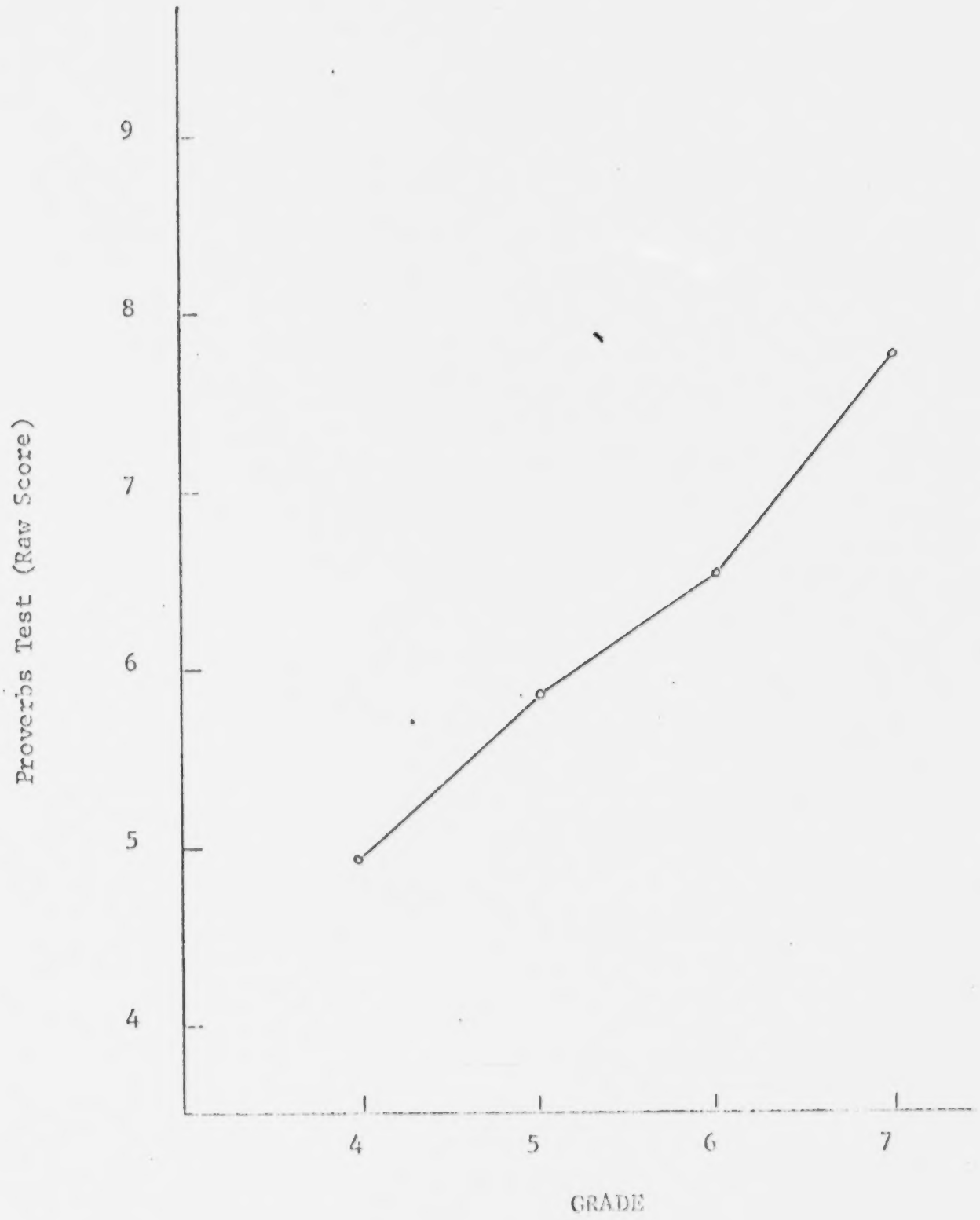


FIGURE 2

Sentential Logic (Ll): Graph of Means by Grade

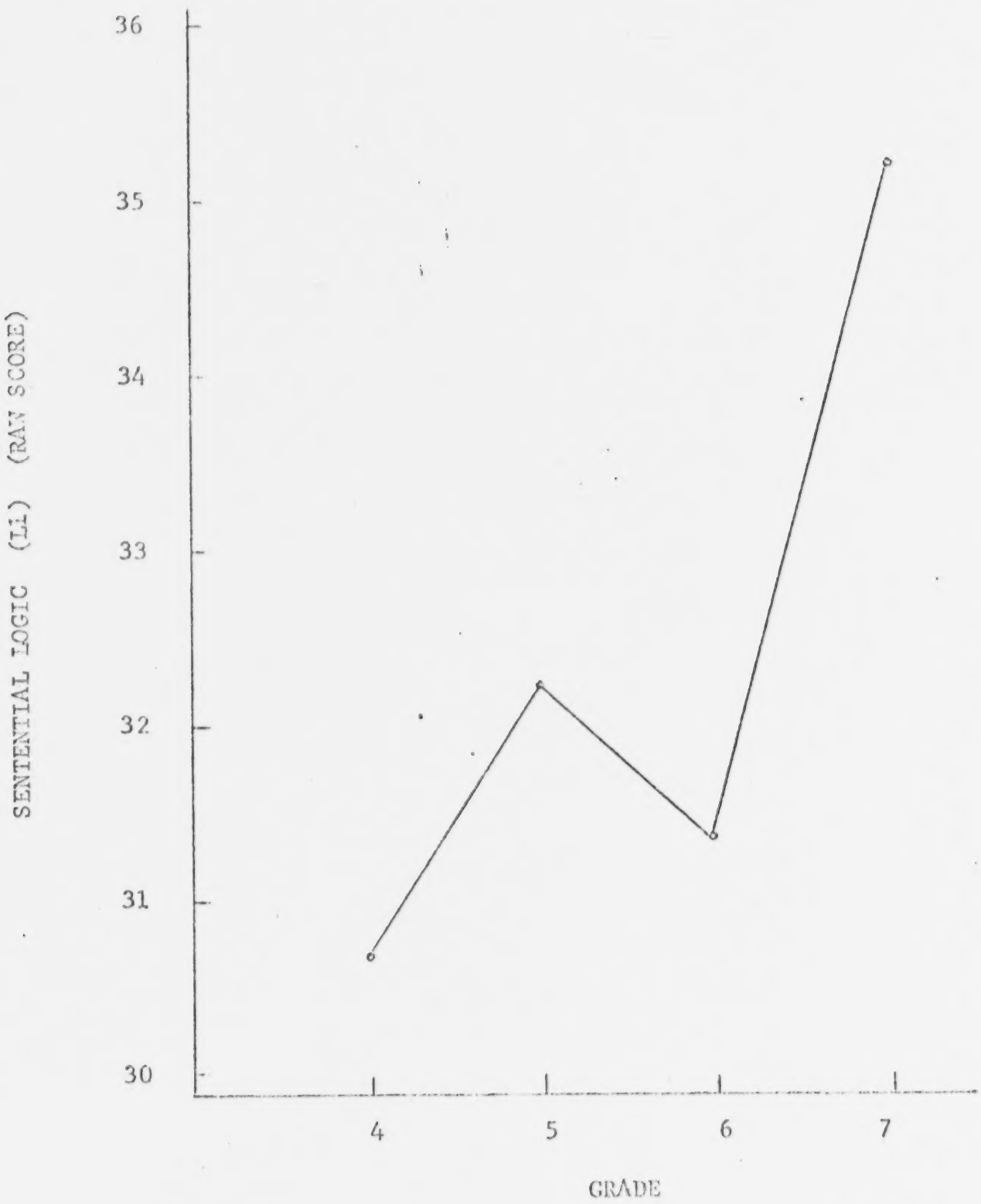


FIGURE 3

Classical Syllogism (L2): Graph of Means by Grade

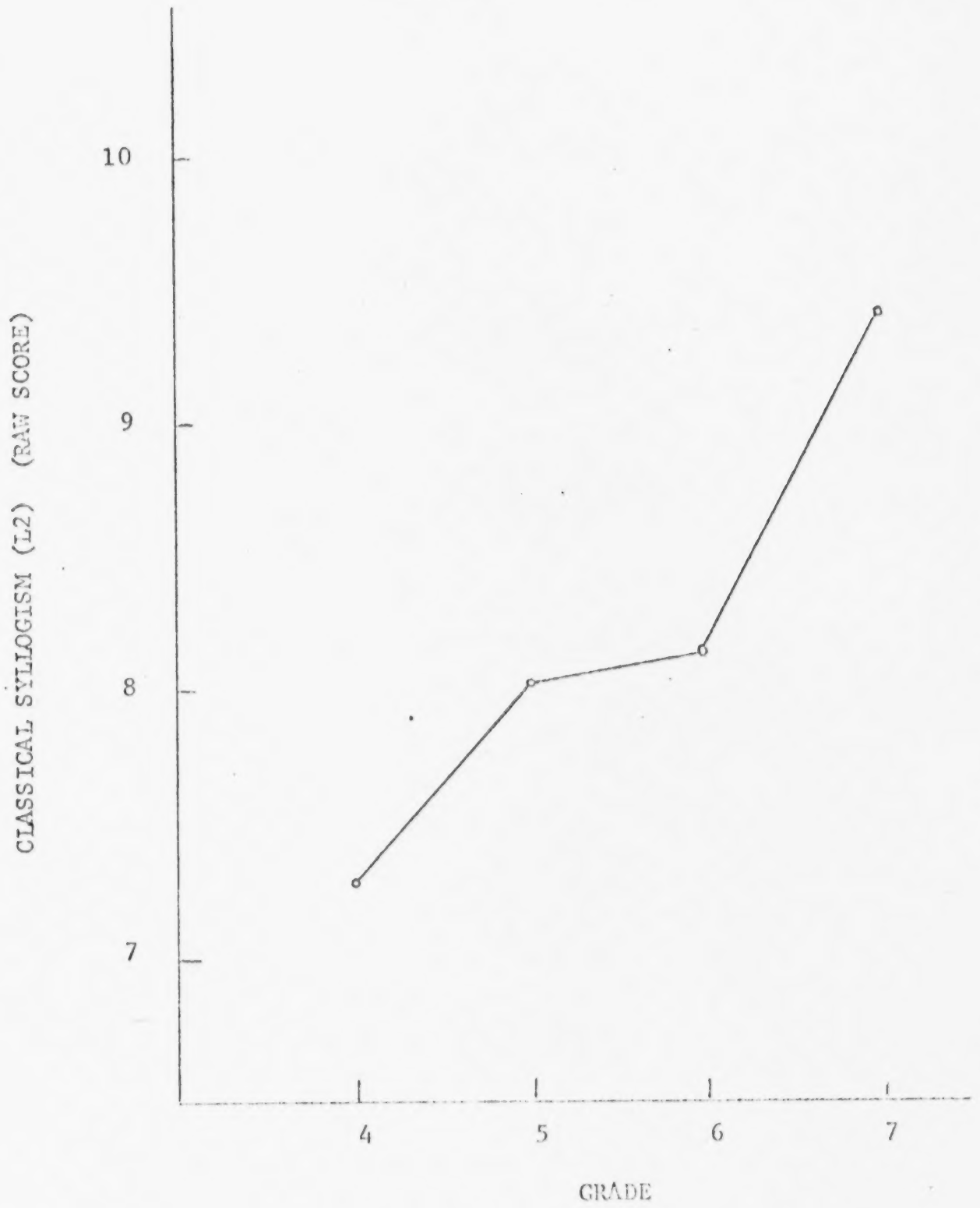


FIGURE 4

Quantificational Logic (L3): Graph of Means by Grade

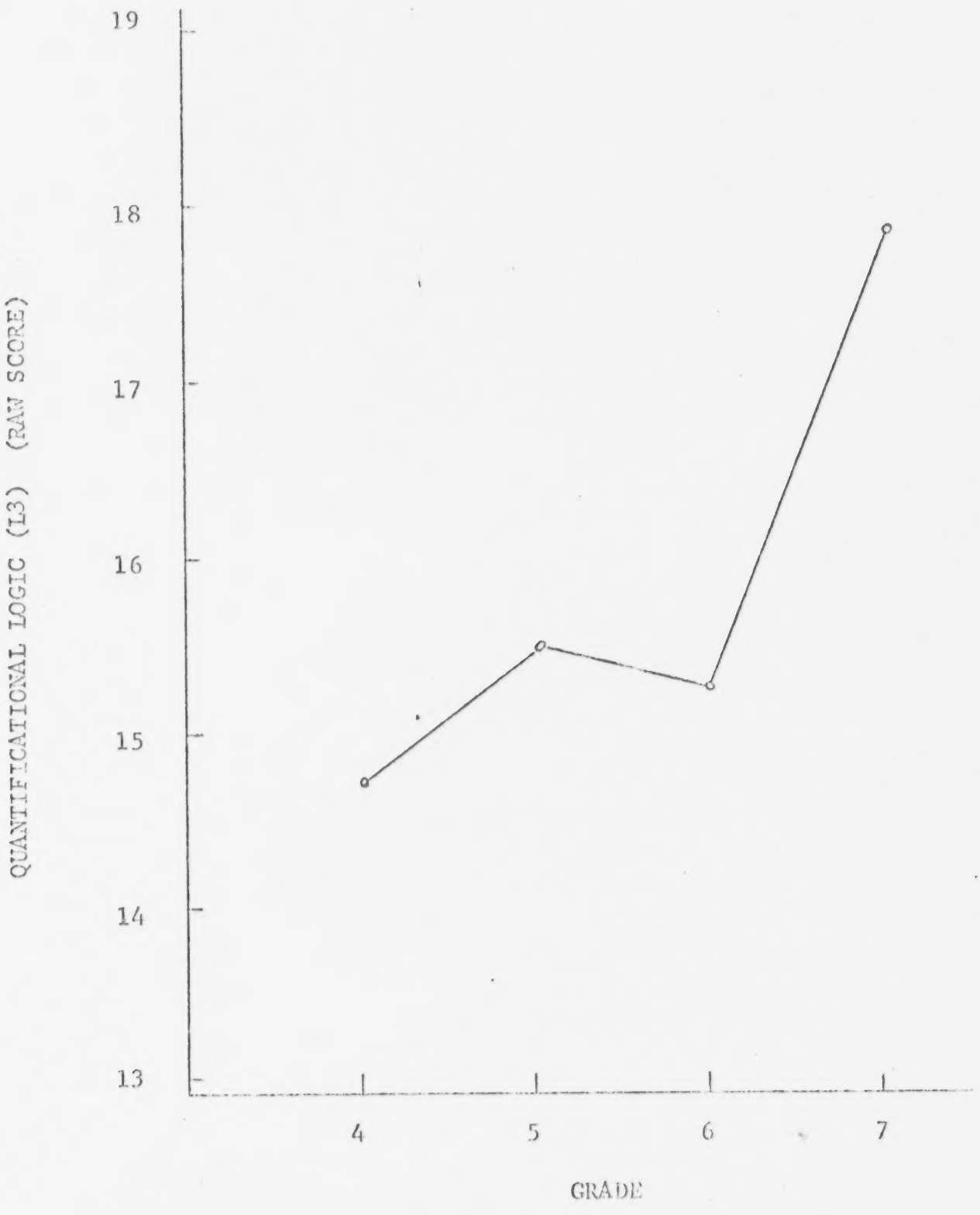
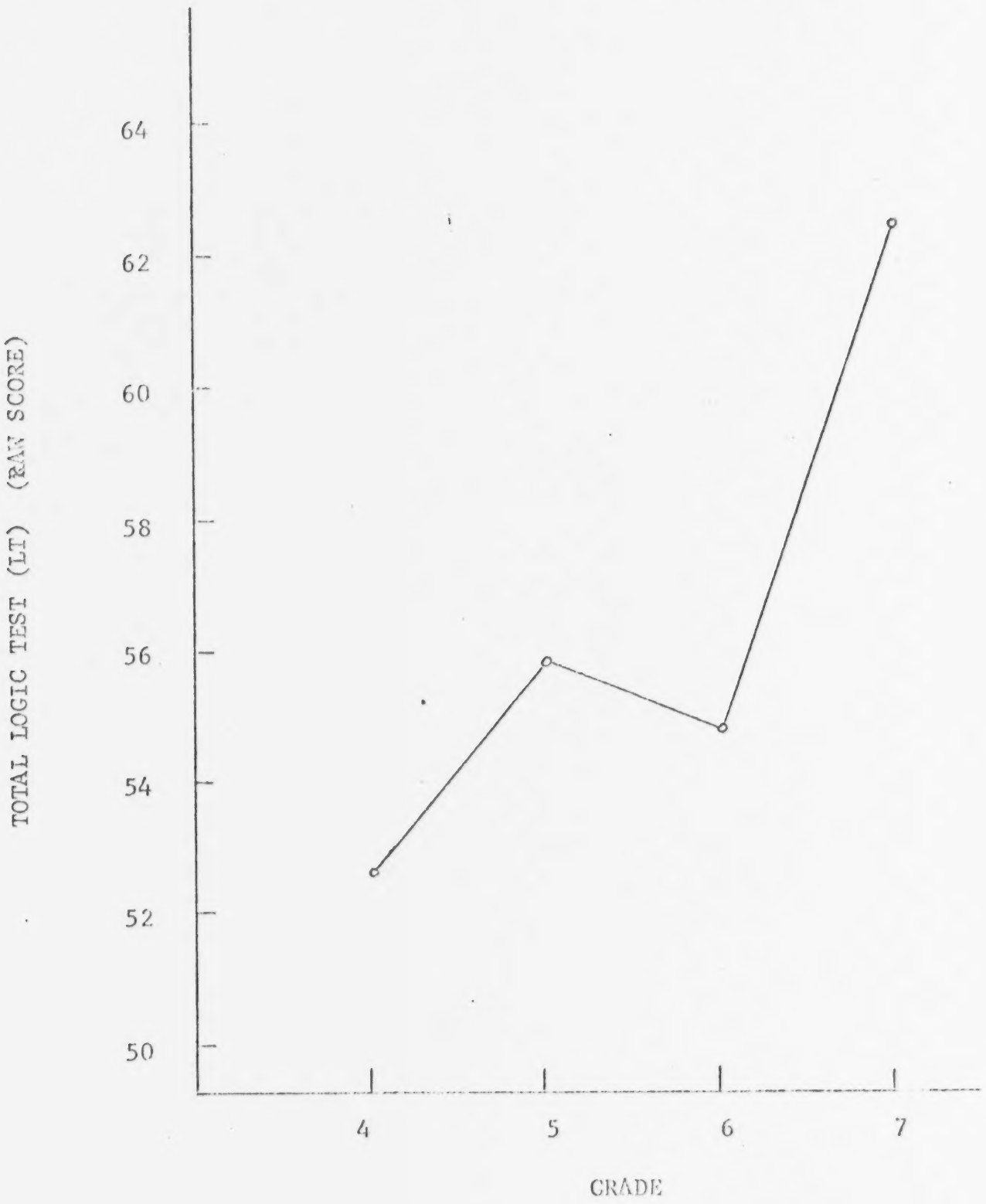


FIGURE 5

Total Logic Test (LT): Graph of Means by Grade



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